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A COMPARISON OF BENTHIC MACROINVERTEBRATES COLLECTED BY DREDGE AND LIMESTONE SUBSTRATE SAMPLER

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A Comparison of Benthic Macroinvertebrates Collected by Dredge and Limestone Substrate Sampler

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Benthic sampling of large streams is difficult due, in part, to the variety of natural substrates encountered. It is usually impossible to obtain a representative fauna, even within a limited area, because of shifting substrates, variable or high stream flow, and a host of other physical factors. Dredges or similar devices, which cut or scrape the bottom, frequently yield samples with a poor variety of aquatic insects and quite often a relatively small number of individuals.

A number of artificial substrate samplers have been built by investigators to facilitate or improve benthic sampling. Scott (1) developed a "brush box" consisting of a cube of 1/4-inch mesh, hardware cloth which was filled with sticks, stones, and other stable substrates. Hester and Dendy (2) constructed a "multiple-plate sampler" with eight, 3-inch square, 1/8-inch thick, hardboard plates. Cauthron (3) used a sampler in which weathered sticks and Spanish

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moss were enclosed with ordinary window screen. The Division of Pollution Surveillance, Federal Water Pollution Control Administration, needed a simple and effective method to sample macroinvertebrate populations in large streams. A device was needed which would provide a place for the organisms to attach or dwell and be easily installed and serviced by persons with different backgrounds of training and experience. Henson (4) described a limestone-filled, cubical sampler initially used by the Water Pollution Surveillance System. Mason et. al. (5) described the limestone-filled, cylindrical sampler-float unit which is presently in use.

This paper presents data on the organisms collected by means of the limestone substrate sampler and by Petersen dredge at Cincinnati and Louisville, Ohio River, and New Harmony, Indiana, Wabash River.

Description of the Limestone Substrate Sampler

The limestone substrate sampler (LSS) is a cylindrical, spot-welded, chrome-plated, Bar-B-Q basket manufactured by the Hewitt Manufacturing Company,[1] National City, California, which can be purchased for less than $2.00 each (Figures 1 and 2). Its overall length is 11 inches (28 cm) and diameter 7 inches (17.8 cm). The cylindrical shape of the basket is formed by 2 mm diameter wires spot welded at right angles forming a mesh with openings 11 mm X 24 mm. The two

[1]Mention of commercial sources or products does not constitute endorsement by the Federal Water Pollution Control Administration.

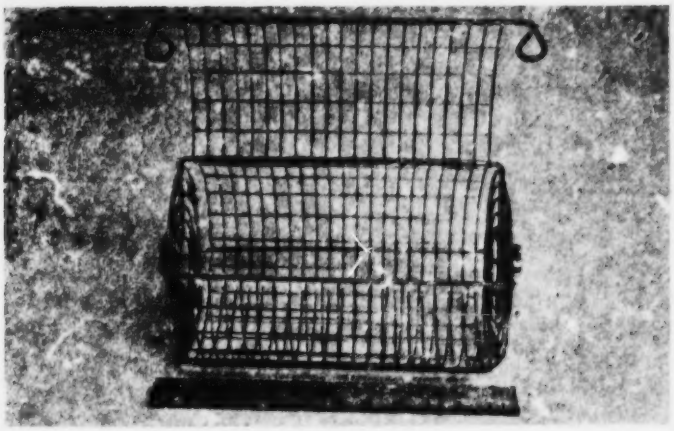

Figure 1. Sampler basket empty.

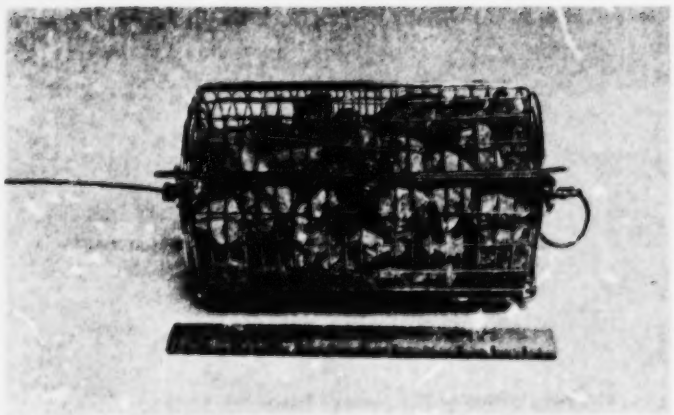

Figure 2. Sampler ready for installation.

ends of the basket consist of 3 mm diameter wire spiraled so that a 10 mm space is between each winding. Four, 4 mm diameter wires, equally spaced around the basket, serve as braces. The sampler contains approximately 0.2 cubic foot (5664 cm^3) of limestone and weighs 17 pounds (7.7 kg). A quarter section of the circular side is hinged and opens its entire length for easy placement or removal of limestone rocks which are approximately 1 to 2 inches (2.5 - 5.0 cm) in diameter.

Methods

The limestone substrate samplers were suspended by 1/8" wire cable from stationary structures to a water depth of approximately five feet. The cable was passed through the longitudinal axis of the sampler and secured at the lower end by a cable clamp.

After the samplers had been in the water for six weeks, the following procedure was used to collect the organisms:

1. The sampler was removed and placed in a tub containing a small amount of water.
2. The rocks were emptied into the tub.
3. The sampler was rinsed to remove any clinging organisms.
4. Each rock was brushed with a stiff-bristled brush. (The clean rocks were replaced in the sampler.)
5. The sample was concentrated in a U. S. No. 30 sieve.
6. The organisms were transferred to a container and preserved in 70% ethanol.

In the laboratory the sample was washed in a U. S. No. 40 sieve. The organisms were placed in a white pan and sorted by hand under 2X magnification. They were counted and identified as to genus or species with exception of the Oligochaeta which were not identified more definitively. Because there was a large number of organisms in some of the Wabash River samples, aliquots were counted and an appropriate factor applied to estimate the number of organisms/sampler.

A series of six, 100 in^2 (645 cms^2) Petersen dredge samples was collected at each sampling location. The samples were washed in a U. S. No. 30 sieve and preserved in 70% ethanol. In the laboratory, the organisms were sorted, identified, and the organisms expressed as individuals/ft^2.

Organisms Collected at Cincinnati and Louisville, Ohio River

Samples from the LSS at Cincinnati were collected four times during the period July 8 to November 16. A total of 13 species, numbering 445 organisms, was present (Tables I and IV). In the four samples, 114 Chironomidae were represented by six species. There were 320 larvae of the caddisfly Cyrnellus fraternus described by Flint (6). Ninety-seven percent of the organisms collected in the LSS at Cincinnati were Chironomidae and Trichoptera.

Four samples were collected from the LSS at Louisville during the summer and fall. A total of 28 species numbering 574 organisms was obtained (Tables II and IV). Chironomidae numbered 171 and were represented by 14 species. There were 254 Trichoptera, 21 Ephemeroptera,

and 76 Mollusca. These four groups represented 91% of the organisms collected.

Cordylophora sp., an epiphytic coelenterate, was usually found on the rocks and framework of the LSS. Chironomid larvae frequently collected in the LSS during 1965 at Cincinnati and Louisville, included Ablabesmyia sp., Chironomus (Dicrotendipes) nervosus, Chironomus (Cryptochironomus) pectinatellae and Psectrocladius sp. Those collected occasionally were Procladius (Procladius) culiciformis, Glyptotendipes (Glyptotendipes) senilis, Polypedilum spp., and Coelotanypus concinnus. Caddisfly larvae of Cyrnellus fraternus were collected in most samples. The most common mayfly nymphs were Caenis sp. and Stenonema sp. The damselfly Argia sp. was found only occasionally.

Generally, molluska occurred irregularly in the LSS. However, a sample collected at Louisville on August 10 contained 62 Corbicula measuring from 1-10 mm.

Oligochaetes were collected only with dredge. The number of midge species collected by dredge was much less than the number with the LSS. Mollusks were also obtained by dredge but practically no Trichoptera, Ephemeroptera, or Odonata.

Although the total number of organisms collected in the LSS was slightly greater at Louisville than at Cincinnati, over twice as many species of Chironomidae were collected from the sampler during the year. The total number of species collected by both dredge and LSS at Louisville was 28, compared to 13 at Cincinnati.

Organisms Collected at New Harmony, Wabash River

The Wabash River has different stream characteristics than the Ohio River. During the time of sampling the Ohio River was approximately 20 feet deep at the Cincinnati sampling location and 12 feet deep at the Louisville location. The Wabash has many shallow, sandy areas and at the sampling location it was scarcely six feet deep. It receives considerable organic enrichment that is conducive to the establishment of large populations of omnivorous and filter-feeding macroinvertebrates.

The potential of the LSS for collecting benthic macroinvertebrates in this type of stream was demonstrated by three samples collected at New Harmony (Tables III and IV). These samples, collected in the late fall and early winter months, contained a total of 1605 organisms and 38 species. Over 700 of the organisms were midges, nearly 500 caddisflies, approximately 150 mayflies, and 100 odonates. Nine stoneflies were present. Approximately 91% of the organisms collected in the three samples belonged in the five insect groups mentioned above.

Eight species, excluding oligochaetes, were collected by dredge from the sandy bottom. Seven of these species were midges and one a burrowing mayfly. About 80% of the 61 organisms collected were oligochaetes and nearly 20% Chironomidae.

Characteristics of Samples from the Limestone Substrate Sampler and Petersen Dredge

The LSS's were in the river as early as May and as late as November 1965. Petersen dredge samples were collected in the late summer of

1962 and 1963. Although the samples were collected in different years, some general comparisons can be made as to the benthic organisms collected by each sampling device.

An inspection of the tables indicates that the LSS is a better collecting device than the Petersen dredge for certain Chironomidae, Trichoptera, Ephemeroptera, Odonata, and other aquatic insects. Oligochaeta, Turbellaria, Hirudinea, Mollusca, Bryozoa, and Coelenterata occur irregularly in the LSS.

The Petersen dredge collects a larger number of those organisms which normally inhabit the bottom sediments such as the bloodworm Chironomus (Chironomus) attenuatus, the burrowing mayfly Hexagenia sp., worms, and mollusks.

Before the effects of pollution on aquatic life are evaluated, it is best to have as many different organisms as possible upon which to draw conclusions. For this reason the Water Pollution Surveillance System utilizes both the LSS and dredge for collecting benthos.

Conclusions

The limestone substrate sampler is a practical device for collecting benthic macroinvertebrates in large streams. It is easy to install and the collections can be made by persons of varying experience and training. The sampler is durable, corrosion resistant, and inexpensive.

LSS samples obtained during the period of warmer water contained many more organisms than samples collected during the period of colder water.

A major advantage of the sampler is that a uniform, attractive substrate is provided for the attachment of bottom fauna. The LSS collects a larger number and variety of immature aquatic insects than the Petersen dredge. It is particularly effective in collecting certain midges, caddisflies, mayflies, stoneflies, coelenterates, and bryozoans. However, relatively few oligochaetes, mollusks, and some of the sediment inhabiting midges and mayflies are collected.

The capability of the LSS to collect a more complete representation of benthic macroinvertebrates is of great value in water pollution investigations.

Table I. Macroinvertebrates Collected at Cincinnati, Ohio River

	Individuals-Limestone Substrate Sampler 1965				No./ft^2 Petersen Dredge	
Sampling Interval	June 8 to July 15	July 15 to Aug 25	Aug 25 to Oct 6	Oct 6 to Nov 16	Aug 8 1963	Oct 11 1962
Diptera Chironomidae	35	60	15	4	16	7
Other					1	
Trichoptera	144	107	62	7		
Plecoptera						
Ephemeroptera	2	1	1		<1	
Odonata Anisoptera					E	
Zygoptera			2	2		
Coleoptera						
Crustacea Decapoda						
Amphipoda					<1	
Isopoda						
Oligochaeta					99	1
Hirudinea						<1
Turbellaria				3		
Mollusca Pelecypoda					1	56
Gastropoda						<1
Bryozoa		X	X			
Coelenterata	X	X	X	X		
Total Individuals	181	168	80	16	117	64
Total *Species	6	9	8	6	9	5

X = Present E = Exuvia * = Excluding the Oligochaeta

Table II. Macroinvertebrates Collected from the Ohio River at Louisville, Kentucky

	Number of Individuals Per Limestone Substrate Sampler - 1965				Av. No. Individuals/ ft^2 in Petersen Dredge Samples	
	May 7 to June 15	June 15 to Aug 10	Aug 10 to Sept 28	Sept 28 to Nov 12	6 samples Aug 12, 1963	6 samples Oct 18, 1962
Diptera Chironomidae Other	35	119	8	9	23 2	3 <1
Trichoptera	5	152	91	6		
Ephemeroptera	21					
Anisoptera						
Zygoptera		1				
Decapoda	1					
Amphipoda			1	6		
Oligochaeta					62	156
Turbellaria		37	2	4		
Hirudinea					5	
Mollusca Pelecypoda Gastropoda		62	6 2	4 2	7 4	19 1
Bryozoa		X			S	S
Coelenterata	X		X	X		
Total Number Individuals	62	371	110	31	103	179
Total Number *Species	13	16	8	10	14	6

X = Present but not counted
S = Statoblasts
* = Excluding the Oligochaeta

Table III. Macroinvertebrates Collected from the Wabash River at New Harmony, Indiana

	Number of Individuals per Limestone Substrate Sampler - 1965			Av. No. Individuals/ ft^2 in Petersen Dredge Samples 6 Samples Aug 14, 1963
	Aug 10 to Sept 29	Sept 29 to Nov 17	Nov 17 to Dec 20	
Diptera				
Chironomidae	217	492	54	12
Other	1			
Trichoptera	300	66	77	
Plecoptera	4		5	
Ephemeroptera	48	80	13	<1
Odonata				
Anisoptera	7	32		
Zygoptera	32	36	2	
Coleoptera	7	8	2	
Crustacea				
Decapoda	1		2	
Isopoda	6			
Oligochaeta		16	35	49
Hirudinea	1			
Turbellaria	5	12	17	
Mollusca				
Pelecypoda	9	12	1	
Castropoda	1			
Bryozoa	X	X	X	S
Total Number Individuals	640	758	207	61
Total Number *Species	31	23	18	8

X = Present but not counted
S = Statoblasts
* = Excluding the Oligochaeta

Table IV. Macroinvertebrates Collected at Cincinnati (C) and Louisville (L) on the Ohio River, and New Harmony (N) on the Wabash River by the Limestone Substrate Sampler and by Petersen Dredge Samplers

Organism	1965 Limestone Substrate			1963 Petersen Dredge		
	C	L	N	C	L	N
Diptera						
Chironomidae						
Tanypodinae						
Tanypus sp. B (Rob.)						X
Ablabesmyia sp.	X	X	X	X	X	X
Coelotanypus concinnus (Coq.)		X	X	X	X	X
Procladius culiciformis (L.)		X	X	X	X	
P. (Psilotanypus) adumbratus Joh.						X
Orthocladiinae						
Orthocladius sp.		X	X			
Psectrocladius sp.	X	X	X			
Cricotopus bicinctus (Meigen)		X				
Chironominae						
Chironomus (Dicrotendipes) sp.		X				
C. (Dicrotendipes) nervosus Staeger	X	X				
C. (Dicrotendipes) modestus Say		X	X			
C. (Chironomus) attenuatus Walk.					X	
C. (Cryptochironomus) digitatus Mall.	X		X	X	X	X
C. (Cryptochironomus) pectinatellae (Dendy and Sublette)	X	X	X			
C. (Cryptochironomus) abortivus Mall.		X				
C. (Tribelos) jucundus Walk.			X			X
Stenochironomus taeniapennis (Coq.)						
Polypedilum (Polypedilum) illinoense (Mall.)		X	X			
P. (Polypedilum) ophioides Townes		X				
Glyptotendipes (Glyptotendipes) senilis (Joh.)	X	X				
G. (Phytotendipes) lobiferus (Say)			X			
Tanytarsus (Tanytarsus) sp.			X			
Ceratopogonidae (1 sp.)			X			
Culicidae						
Chaoborus (Sayomyia) punctipennis (Say)				X		
Trichoptera						
Cyrnellus fraternus (Banks)	X	X	X			
Hydropsyche orris Ross			X			
Potamyia flava (Hagen)			X			
Leptocella sp.			X			
Macronemum sp.			X			
Arthripsodes sp.		X				
Agraylea sp.		X				

Table IV. Continuation

Organism	1965 Limestone Substrate			1963 Petersen Dredge		
	C	L	N	C	L	N
Ephemeroptera						
Stenonema sp.	X	X	X	X		
Caenis sp.		X	X			
Tricorythodes sp.	X		X			
Hexagenia sp.			X			X
Plecoptera						
Perlidae						
Acroneuria sp.			X			
Odonata						
Zygoptera						
Argia sp.	X	X	X			
Anisoptera						
Gomphus crassus			X	E		
G. vastus			X			
Neurocordulia sp.			X			
Erpetogomphus sp.			X			
Coleoptera						
Stenelmis sp.			X			
Crustacea						
Amphipoda						
Gammarus sp.		X		X		
Isopoda						
Asellus sp.			X			
Decapoda						
Orconectes obscurus (Hagen)		X	X			
Cambarus sp.			X			
Oligochaeta			X	X	X	X
Turbellaria	X	X	X			
Hirudinea			X		X	
Mollusca						
Gastropoda						
Bulimidae (1 sp.)		X				
Viviparidae			X			
Viviparous sp.					X	
Lioplax sp.					X	

Table IV. Continuation

Organism	1965 Limestone Substrate C	L	N	1963 Petersen Dredge C	L	N
Continuation of						
Mollusca						
Gastropoda						
Physidae		X				
Physa						
Amnicolidae					X	
Amnicola sp.					X	
Somatogyrus sp.						
Pleuroceridae					X	
Pleurocera sp.						
Pelecypoda		X		X	X	
Corbicula fluminea Müller			X		X	
Sphaerium sp.				X		
Pisidium sp.					X	
Leptodea sp.						
Bryozoa	X	X			S	
Pectinatella sp.			X		S	
Plumatella repens (L.)			X			S
Lophopodella sp.						
Coelenterata	X	X				
Cordylophora sp.						
Total *Species	13	28	38	9	14	8

E = Ecavia
S = Bryozoan Statoblasts
* = Excluding the Oligochaeta

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